Proposal for a Coordinate System for Bo

Hans Jostlein 1/24/2007

Introduction

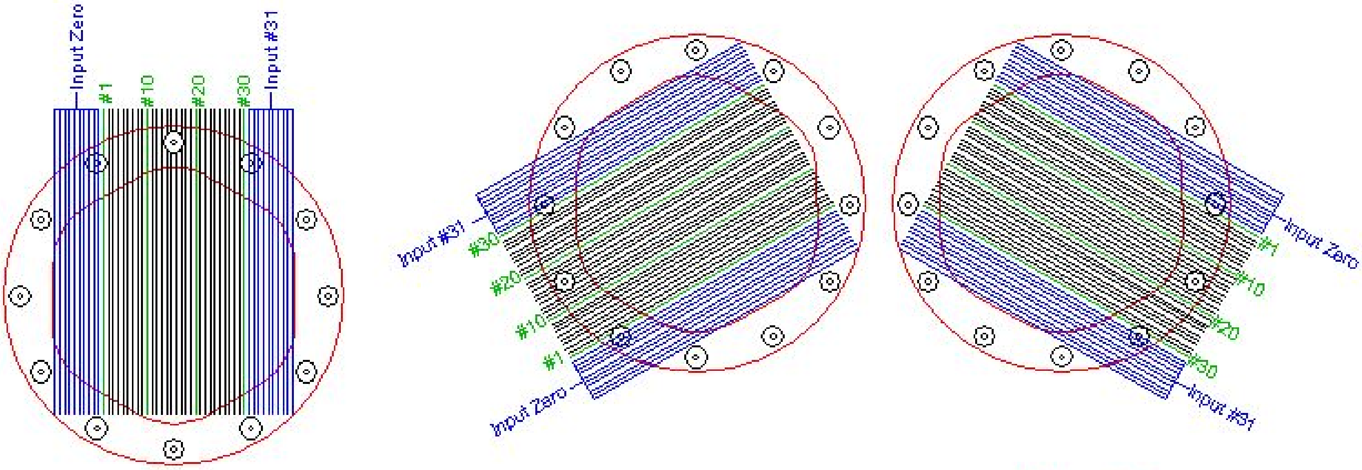
In a recent Email, Dan Edmunds asked:
“Is there or can we make an official coordinate system for this detector ? “

This note tries to answer this question, maybe in an unexpected way.

Wire Orientations in the Bo TPC

The Bo TPC has three planes, each with 50 wires, from which the central 30wires are connected to individual preamp/ readout channel, while the rest are connected to input channel zero (first 10 wires) or input channel 31 (last 10 wires).
The planes can be assembled with relative rotations in increments of 30 degrees. We assume for now that we will choose a 120 degree rotation between successive planes.
As a consequence and as shown in the picture, one can select any common wire number for all three planes, and the wires will form an isosceles triangle, centered on the chamber frames (note that this would not be true if the inter-plane rotation was 60 degrees instead of 120 degrees).

We follow the naming scheme where the first induction plane (the one nearest to the cathode) is Plane A, followed by Plane B, with Plane C being the collection plane.



Plane A Plane B Plane C

Each plane has 50 wires.
We only read out the 30 central wires,
numbered 1 through 30.
The remaining wires connect jointly
to input zero and input 31,
and are no longer considered here.

TPC Coordinate System for Bo

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Am Anfang war der Draht

All data acquisition starts with electrical signals on sense wires, which eventually get amplified and digitized.

In the present discussion we will be ignoring the drift coordinate, except for this rule: Since the drift time between planes is a constant, let us time shift the signals on plane A and B to synchronize them with the signal from the same electron cloud at plane C (in other words we have just eliminated the gaps between the planes).
Furthermore we will consider only a single electron cloud of small dimension passing through the wires. Tracks would generate a continuous line of such clouds, but that is not discussed here.

A typical data point would consist, in the simplest case, of a wire number on each plane, corresponding to a common hit.
It is interesting to note that in our configuration the sum of the wire numbers is constant, independent of where the hit is. I call this the “checksum”. (I suspect that such checksums can be constructed for systems with arbitrary wire spacings and rotations, but

have not yet tried to prove that). For our geometry, the check sum is three times the central wire number, i.e. 3 * (1+31)/2 = 46.5

Let's define "a" as the wire address that was hit in plane A, and so on.
We see now that a data point has three independent pieces of information, namely any three out of this set of four:

a, b, c, checksum

due to the definition

Checksum = a +b + c.

The checksum is a measure of how closely the three hit wires cross, and will be useful in finding hits. (Note that in general wire numbers can be centroids of clusters , and be no longer integers.)

Interpretations of a, b, c as Coordinates

If we consider only, say, a and b, then the two numbers span a non-normal Cartesian coordinate system.

Why would we bother to use a non-normal Cartesian system ?

There are several reasons to do so:

a. Points in such a system can be easily transformed to a normal Cartesian system by the usual transformation:
x = d * a + e * b
Y = f * a + g * b,
Where the constants d,e,f,g are simply calculated (once) from the chamber geometry.

b. All data pass through a stage where they are represented by wire numbers rather than coordinates. We propose here to do all work in that "wire number system"

c. The wire number system treats all three planes on an equal footing

d. Most importantly, location errors of hits are orthogonal to the wires . In a Cartesian system they would appear as rotated error ellipses with large x-y correlation coefficients. The simplest example of that is the checksum, which is a discriminant for how well all three plane hits coincide. For the simplest case where all three wire plane errors have the same rms value "delta", the checksum will have an rms spread of sqrt(3) * delta.

Conclusions

We propose to do all track finding and reconstruction in the “wire number system” rather than in a conventional Cartesian, unit vector , or cylindrical system. The main advantages are that this system is pre-defined by the geometry and data numbering, and that errors are orthogonal and uncorrelated.
It will be interesting to see how far one can take this concept.